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Dissociation Between Distinctive Tone Production and Poor Tone Perception in Cantonese: Preliminary ERP Results

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Introduction

Various theoretical views regarding the relationship between speech perception and production can be found as to whether perception and production are supported by the same (Hickok, 2001) or different phonological representations (Hillis, 2001), or whether perception must involve access to the motor system (Liberman & Mattingly, 1985). Double dissociation between language comprehension and production exhibited by language-impaired individuals is compatible with separate input and output representations or functionally distinct access for processes in the two modalities, but challenges accounts of production-based perception and unitary representations supporting perception and production. This paper reports preliminary behavioural and electrophysiological findings of neurologically unimpaired speakers of Cantonese who produce all six distinctive tones in the language but fail to discriminate certain tonal contrast confirmed by event-related potentials (ERP).

Method

The participants were two native Cantonese speakers who produced six distinctive tones with 100% accuracy. While one (control) could discriminate these tones perfectly including high level (T1) vs. mid-low level (T6) (T1/T6) and low-falling (T4) vs. T6 (T4/T6) contrasts, the other (near-merger; Labov et al., 1991) performed 100% correct for T1/T6 but at chance for T4/T6. A passive oddball paradigm was used to examine whether neural responses measured by mismatch negativity (MMN) conform to their behavioural patterns. Electrocephalography (EEG) was recorded from 64 Ag/AgCl electrode sites arranged according to the International 10-20 system. Raw EEG data were preprocessed and underwent Independent Component Analysis to mathematically remove artefacts and noisy channels. Statistical differences between the deviant trials and the immediately preceding standard trials were assessed by the cluster-based permutation test.

Results and Discussion

ERP results at Cz are shown in Figure 1. Significant negative clusters reflecting MMNs to T1/T6 were observed in both participants with maximal activities at the fronto-central electrodes. Additionally, MMN found in the control was followed by a positive cluster at similar electrodes, which was classified as P3a. Regarding the T4/T6 contrast, no significant clusters were found in the near-merger, whereas two negative clusters (248-314 ms and 484-568 ms post-stimulus onset) were observed in the control. The former was marginally significant and maximal at centro-parietal electrodes; the latter, considered an MMN, had a fronto-central distribution.

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In summary, participants' neural responses were consistent with behavioural observations. Nonetheless, ERPs reveal much richer information showing different neural activities may underlie the same behavioural pattern between participants (T1/T6) and within a participant (T1/T6 vs. T4/T6). They potentially provide important insights into understanding this theoretically challenging dissociation with good production vis-à-vis poor perception.

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